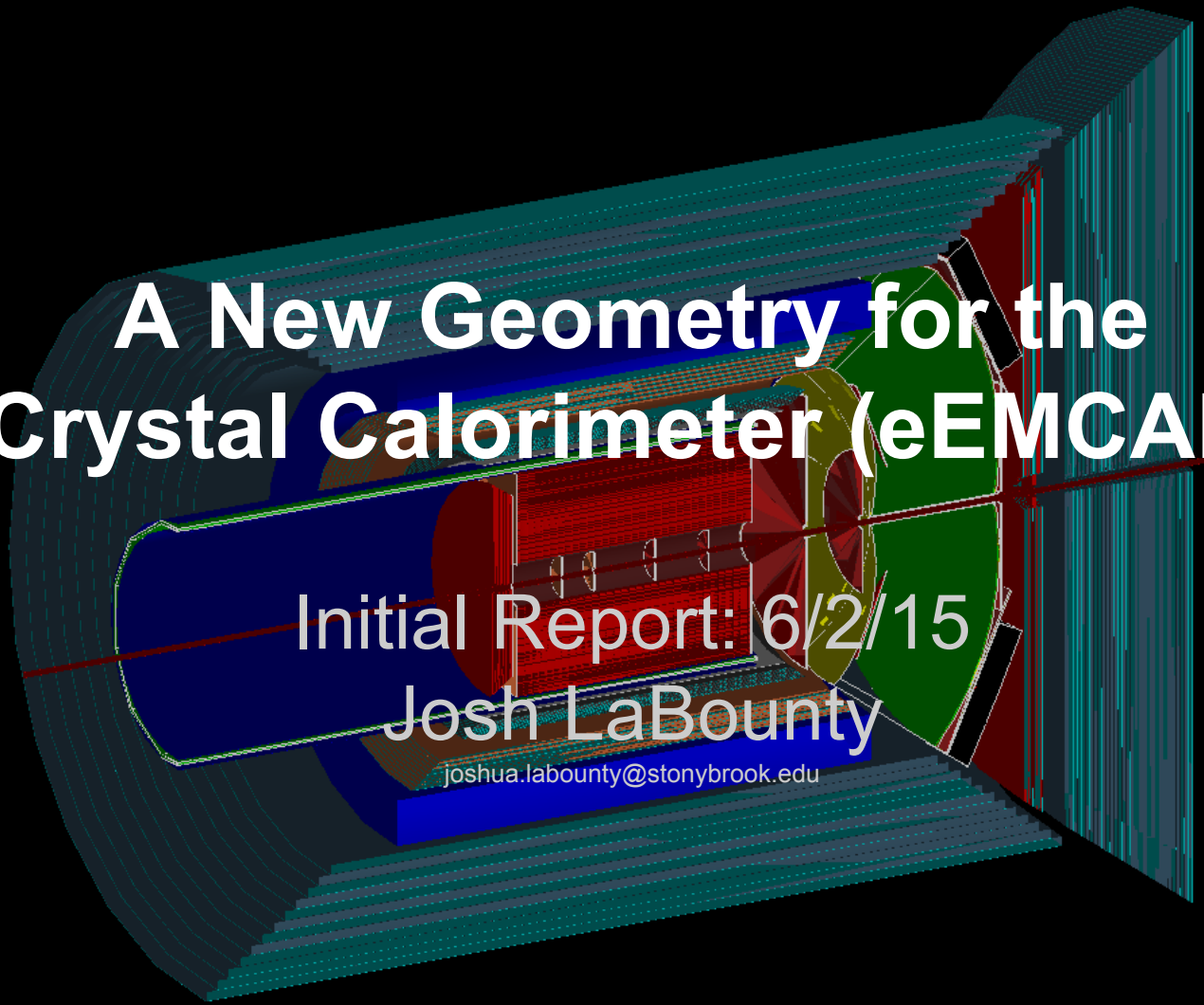
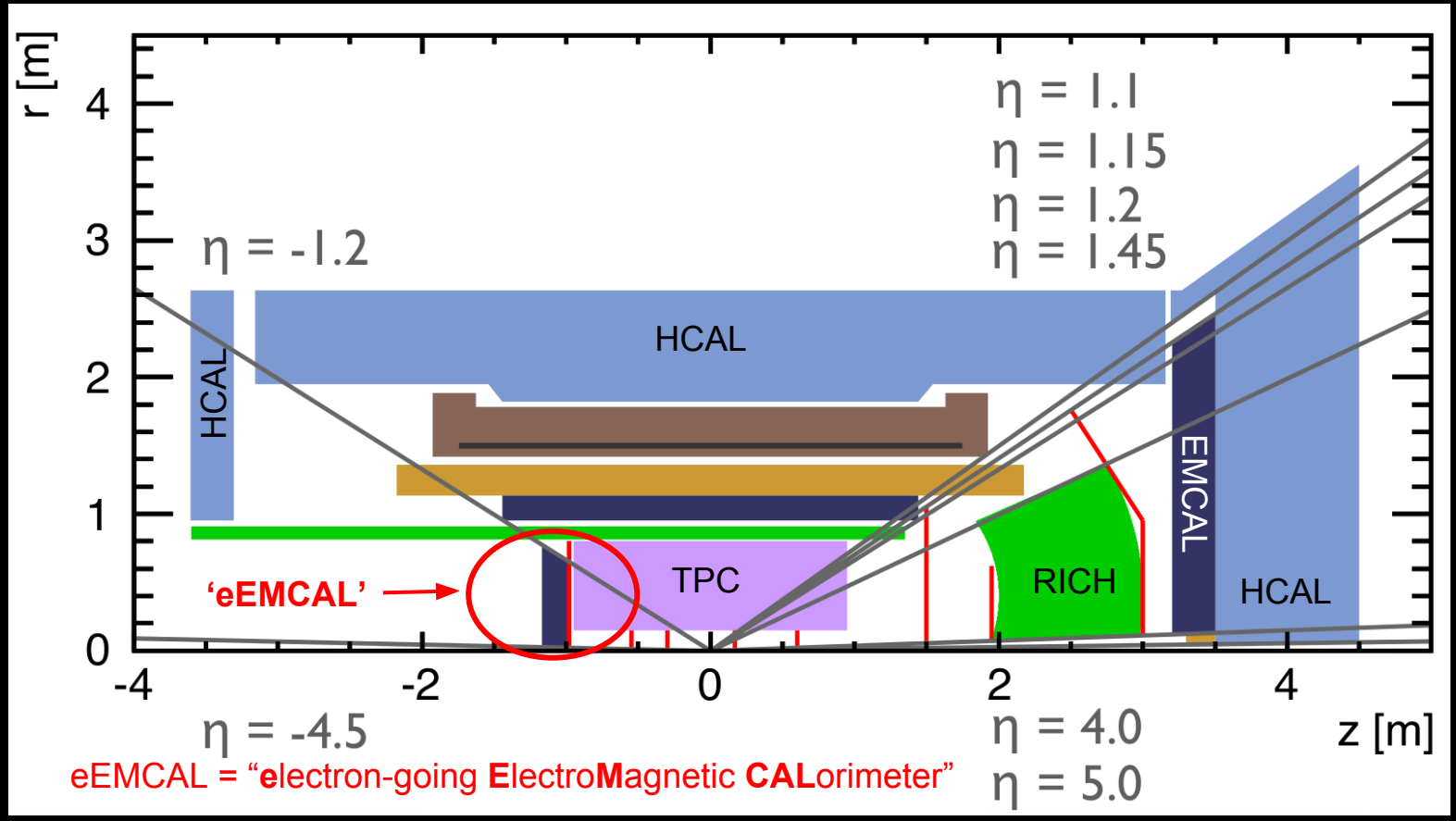


A New Geometry for the Crystal Calorimeter (eEMCAL)

Initial Report: 6/2/15

Josh LaBounty
joshua.labounty@stonybrook.edu

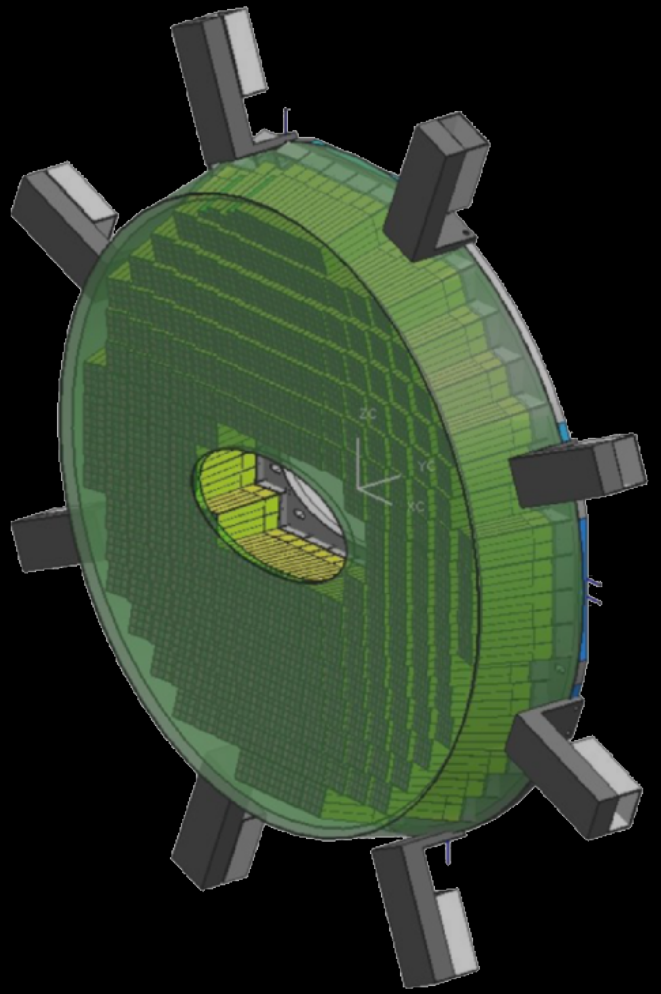
Location



eEMCAL = "**e**lectron-going **E**lectro**M**agnetic **CAL**orimeter"

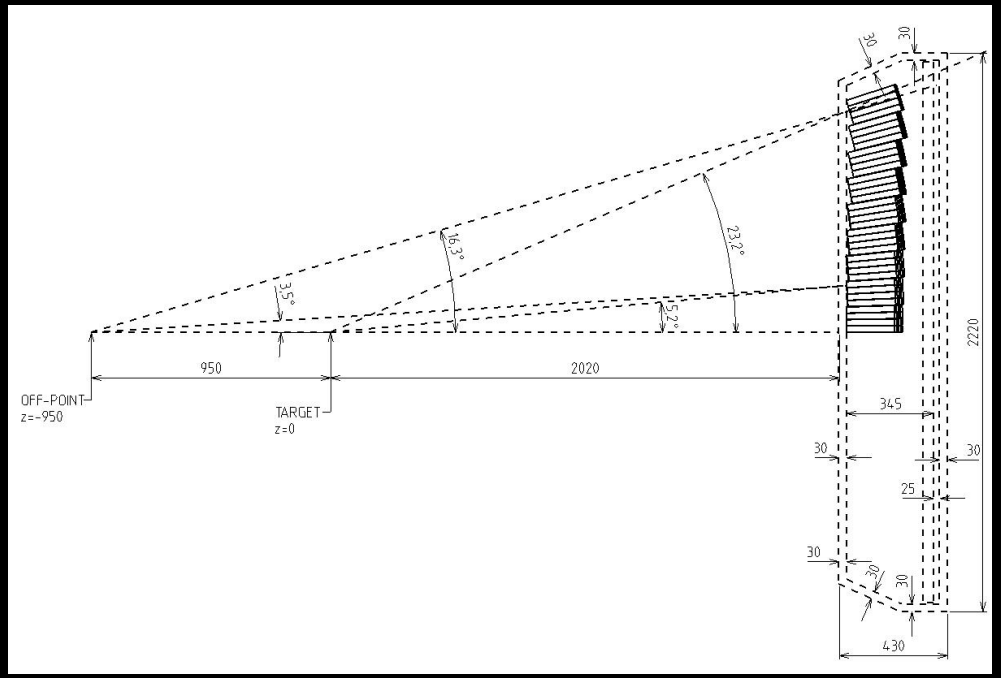
Goal

- A geometry for our crystal calorimeter modelled after the one used by the PANDA Experiment

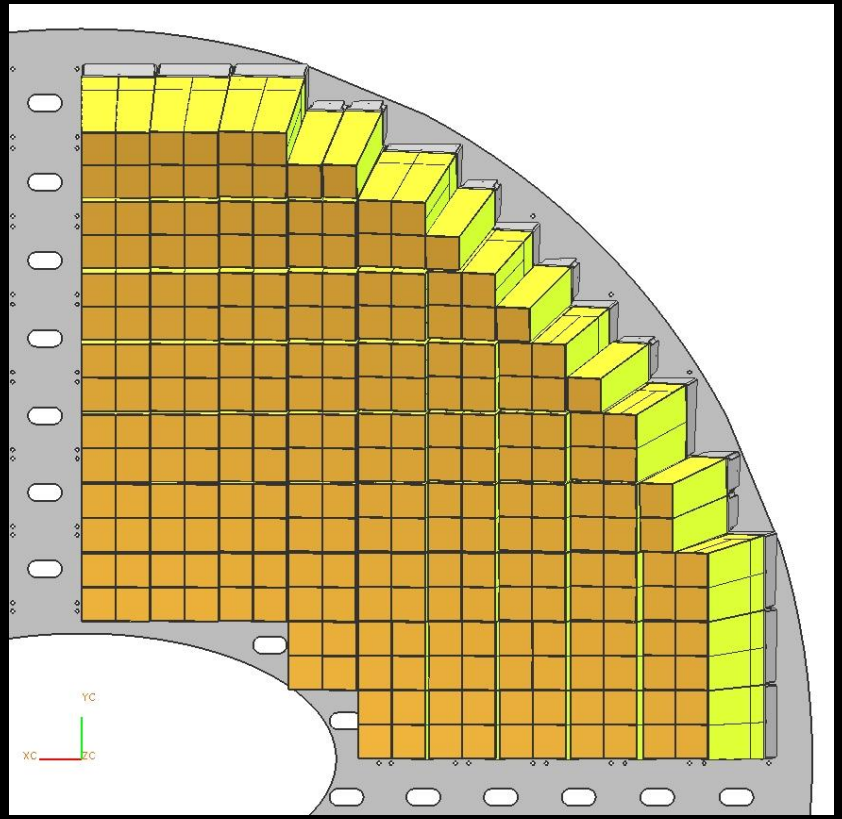


arXiv:0810.1216v1 -- Figure 7.30

Goal

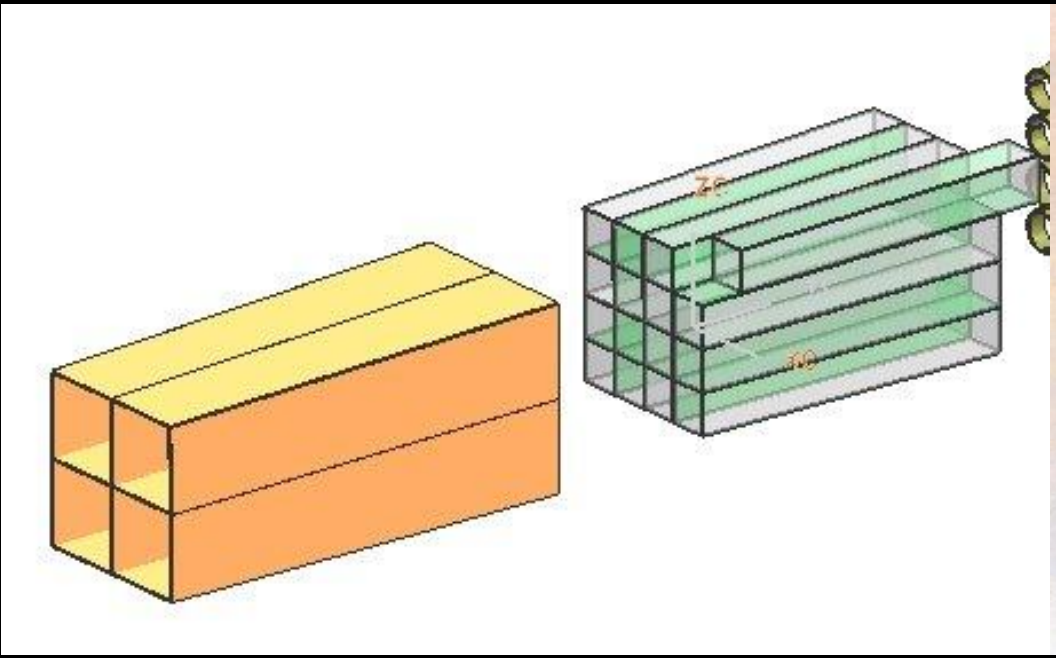


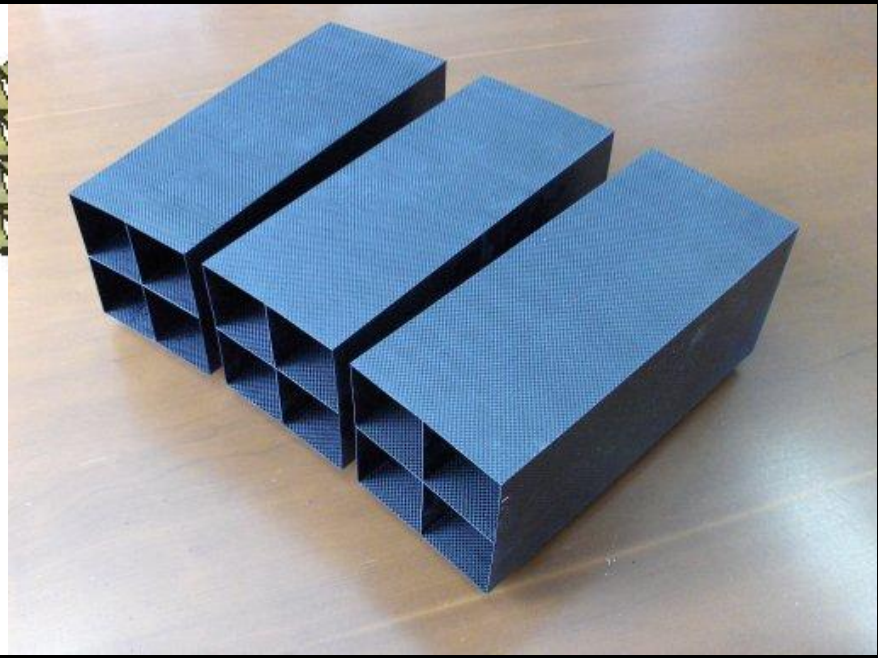
arXiv:0810.1216v1 -- Figure 7.23



arXiv:0810.1216v1 -- Figure 7.29

Goal





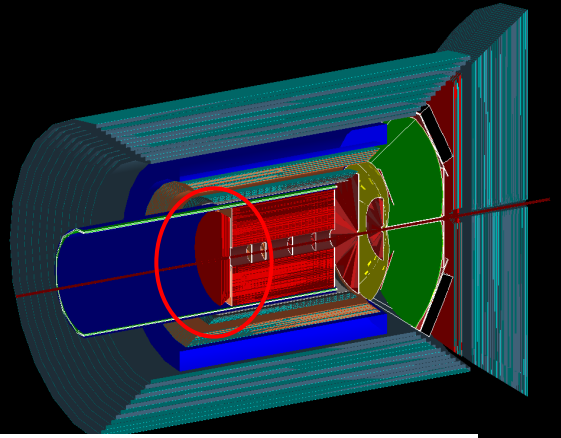
Carbon Fiber Backbone

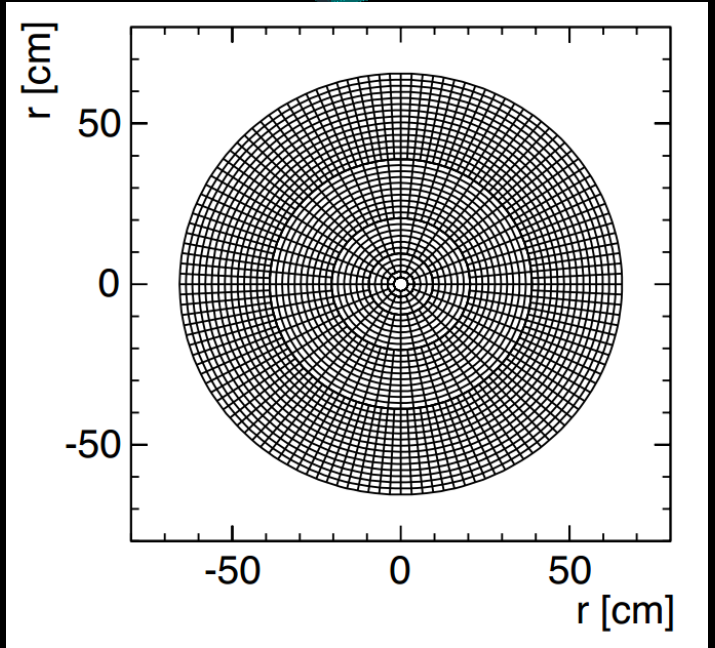
arXiv:0810.1216v1 -- Figure 7.27

arXiv:0810.1216v1 -- Figure 7.26

Previous Design

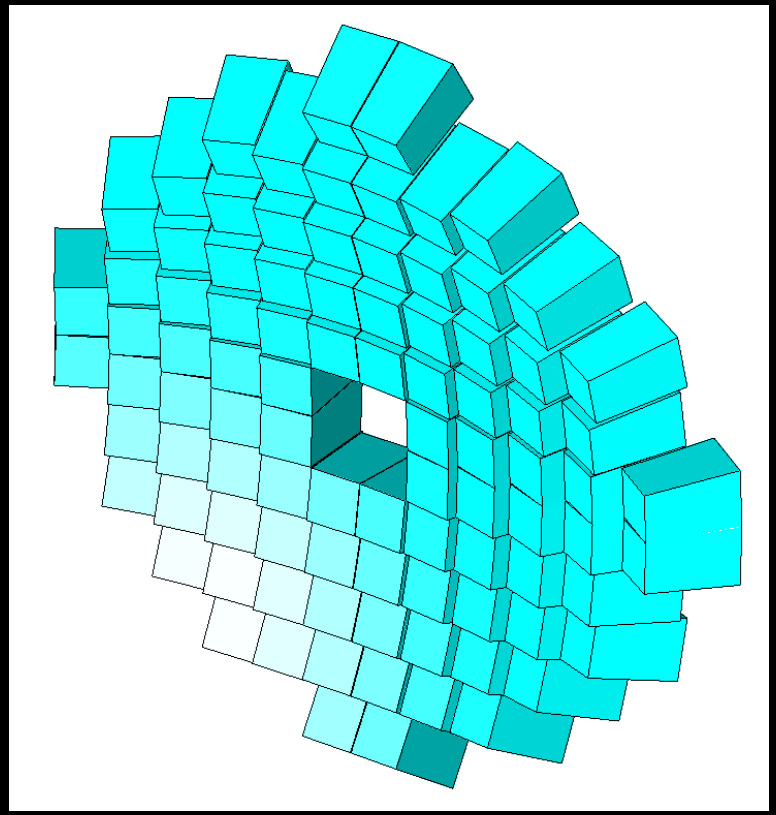
- Previous implementation was simplified
  - Starting z-position: -99.0 cm
  - Thickness: 18 cm
  - Material: $PbWO_4$
- Split into 5 sections via RawTowerBuilderCone() depending on ‘η’
  - $-1.2 \leq \eta \leq -4.5$





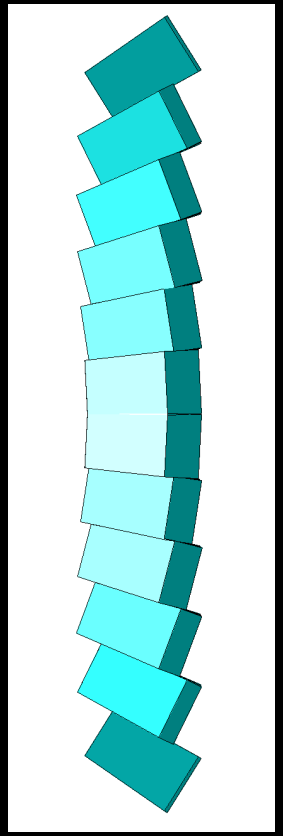
Current Implementation

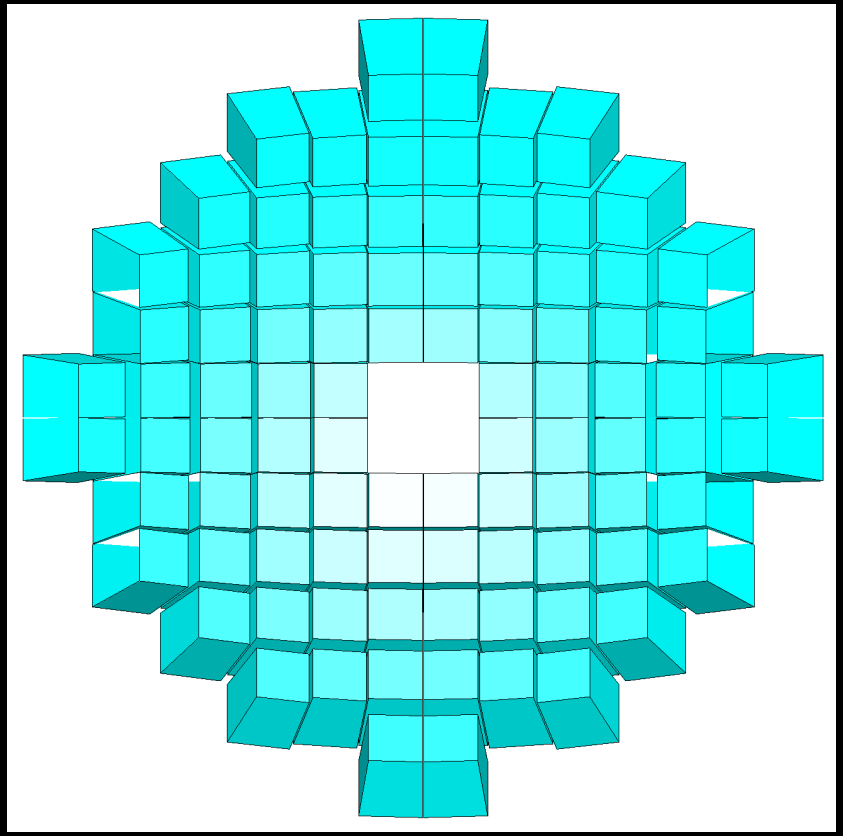
- 92 $PbWO_4$ units arranged in an off-pointing geometry
  - Front face: 100.38 mm x 100.38 mm
  - Back face: 118.63 mm x 118.63 mm
  - Length: 180.00 mm
- Each unit represents a 4x4 block of $PbWO_4$ crystals



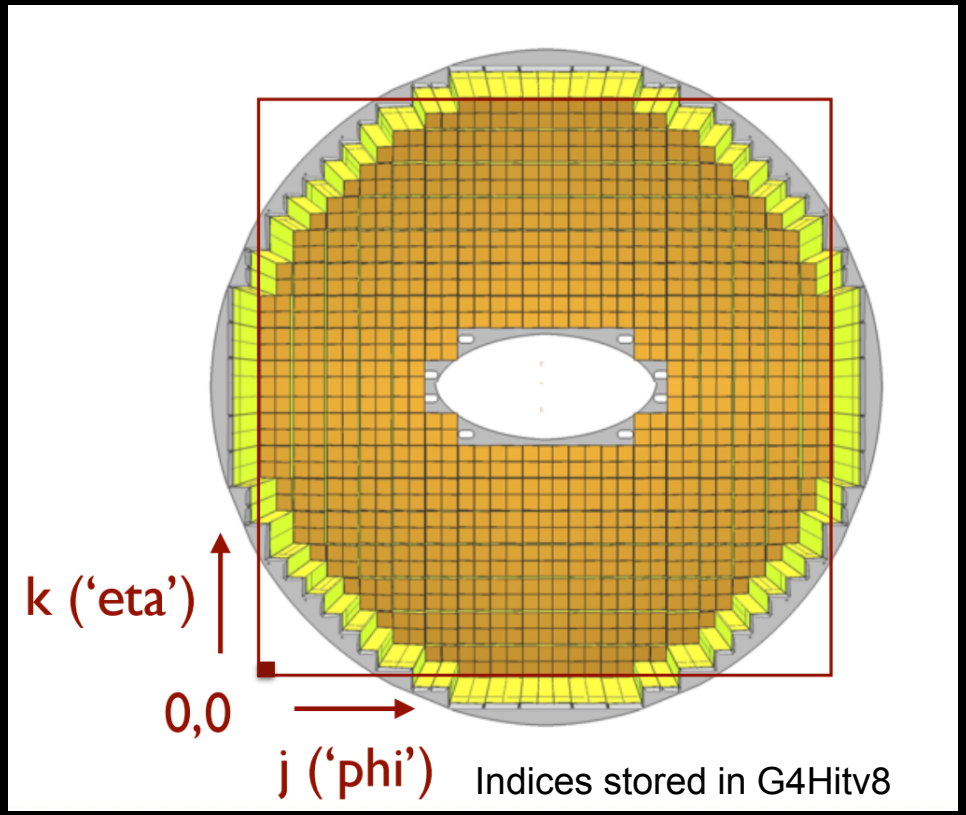
https://github.com/jlabounty/coresoftware
commit: `2f4ab1754c9131a127d66d7ab1e20eb7a005f4f5`

Current Implementation

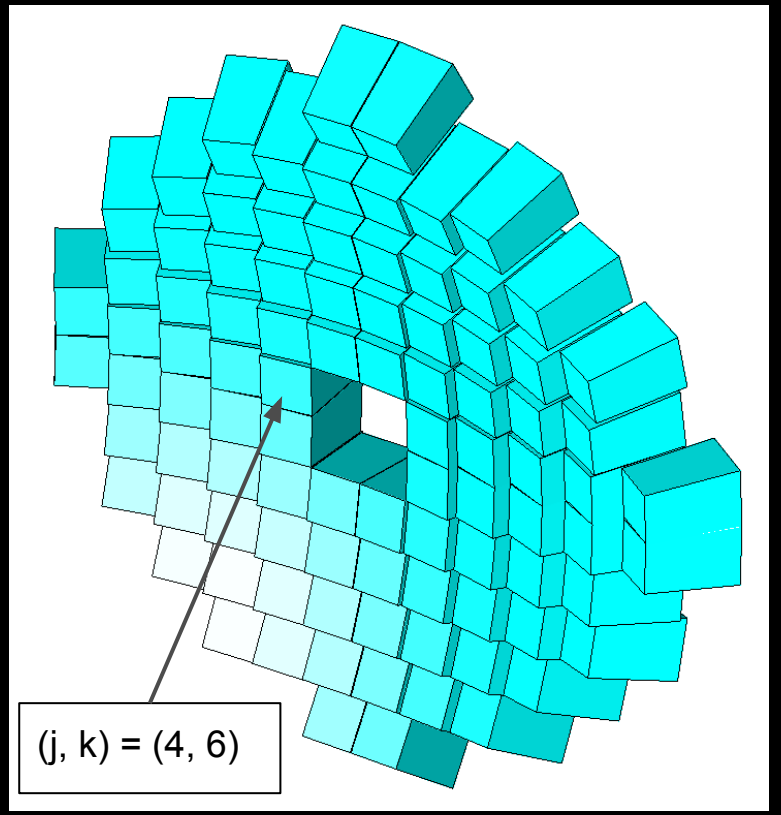




Current Implementation



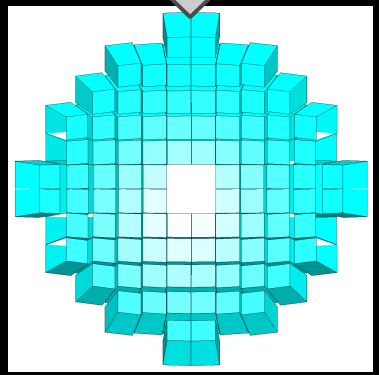
Indices stored in G4Hitv8



Current Implementation: Mapping

- Geometry read in at runtime from data file
  - 1 quadrant sufficient to define whole geometry
- Can be altered without recompiling

4	6	166.1892238219	54.9152994006	-1088.9582747501	-0.1519608092	0.0506536031
3	6	279.439447894	54.9152994006	-1092.0533424522	-0.2532680153	0.0506536031
2	6	395.6841942024	54.9152994006	-1094.1019168774	-0.3545752214	0.0506536031
1	6	515.9956965577	54.9152994006	-1095.0829911746	-0.4558824276	0.0506536031
0	6	641.7228955142	54.9152994006	-1094.9865050398	-0.5571896337	0.0506536031
5	7	55.2474676171	165.8220171718	-1088.9778145166	-0.0506536031	0.1519608092
4	7	166.8151156437	165.8220171718	-1093.0452934741	-0.1519608092	0.1519608092
3	7	280.4754672293	165.8220171718	-1096.0561073166	-0.2532680153	0.1519608092
2	7	397.11971732	165.8220171718	-1097.979382029	-0.3545752214	0.1519608092
1	7	517.8160030647	165.8220171718	-1098.7953956303	-0.4558824276	0.1519608092
5	8	55.4066797113	278.8316221065	-1092.1182802131	-0.0506536031	0.2532680153
4	8	167.2911193058	278.8316221065	-1096.1535556567	-0.1519608092	0.2532680153
3	8	281.2633813392	278.8316221065	-1099.1002926982	-0.2532680153	0.2532680153
2	8	398.2114623106	278.8316221065	-1100.9282743901	-0.3545752214	0.2532680153
1	8	519.2003837732	278.8316221065	-1101.6187559219	-0.4558824276	0.2532680153
5	9	55.5141251006	394.8419821512	-1094.2376453326	-0.0506536031	0.3545752214
4	9	167.6123536882	394.8419821512	-1098.2511880108	-0.1519608092	0.3545752214
3	9	281.7951106567	394.8419821512	-1101.1546823774	-0.2532680153	0.3545752214
2	9	398.9482340114	394.8419821512	-1102.9183549116	-0.3545752214	0.3545752214
5	10	55.5687019995	514.9277346013	-1095.3141771097	-0.0506536031	0.4558824276
4	10	167.7755247328	514.9277346013	-1099.316680627	-0.1519608092	0.4558824276
3	10	282.06520263	514.9277346013	-1102.1982098715	-0.2532680153	0.4558824276
5	11	55.569850756	640.4401349353	-1095.3368363834	-0.0506536031	0.5571896337



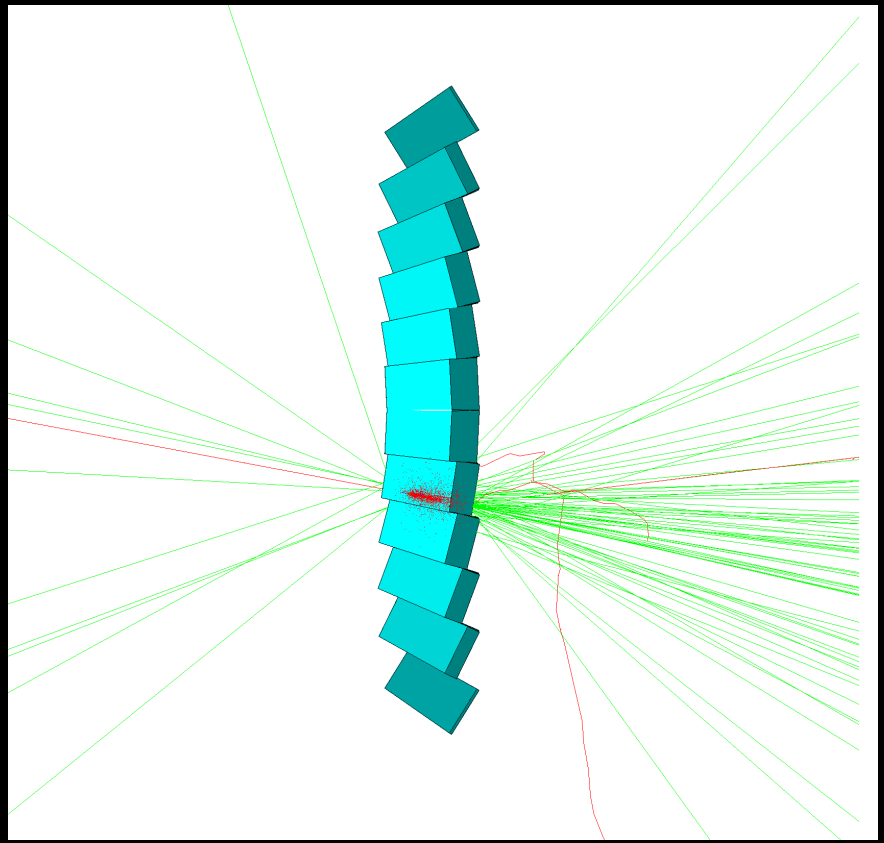
[j, k, x, y, z, α, β]

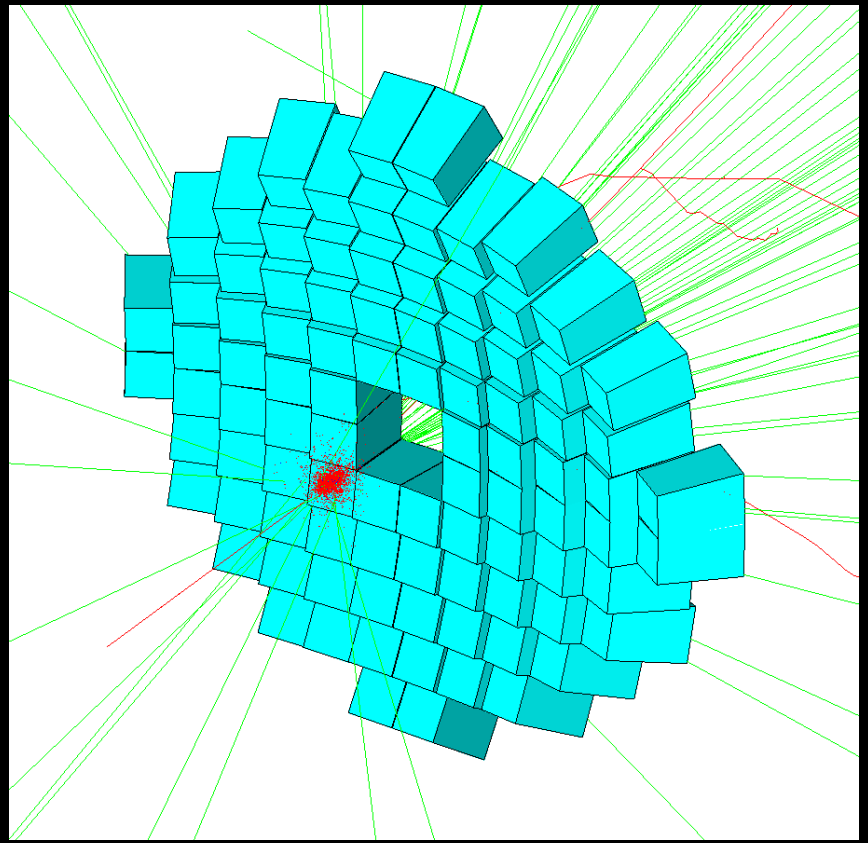
Indices

Coordinates of center in mother volume

Rotation about center

Current Implementation



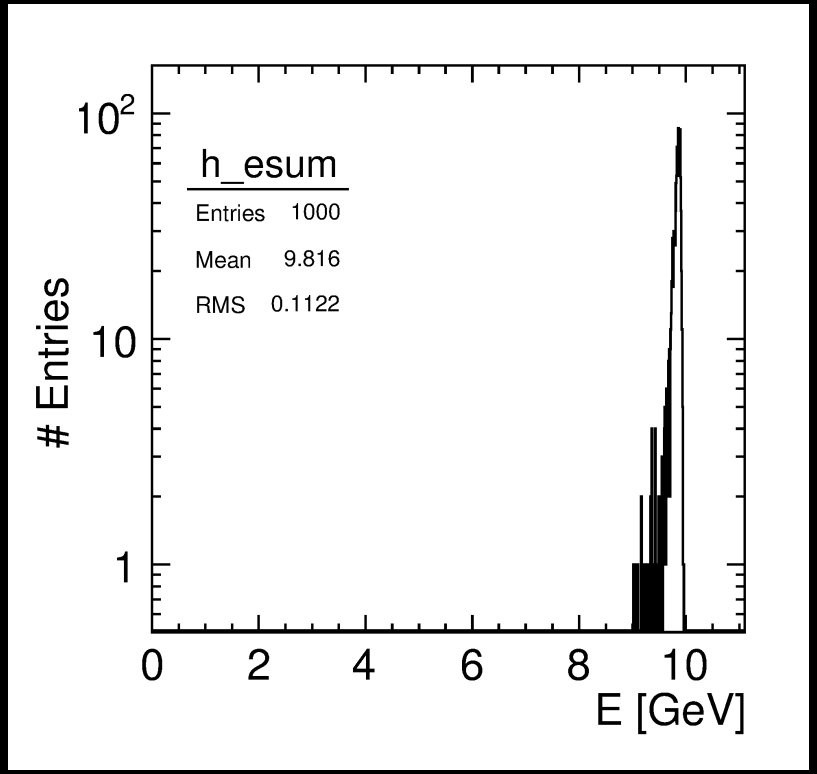


Quick Cross Check

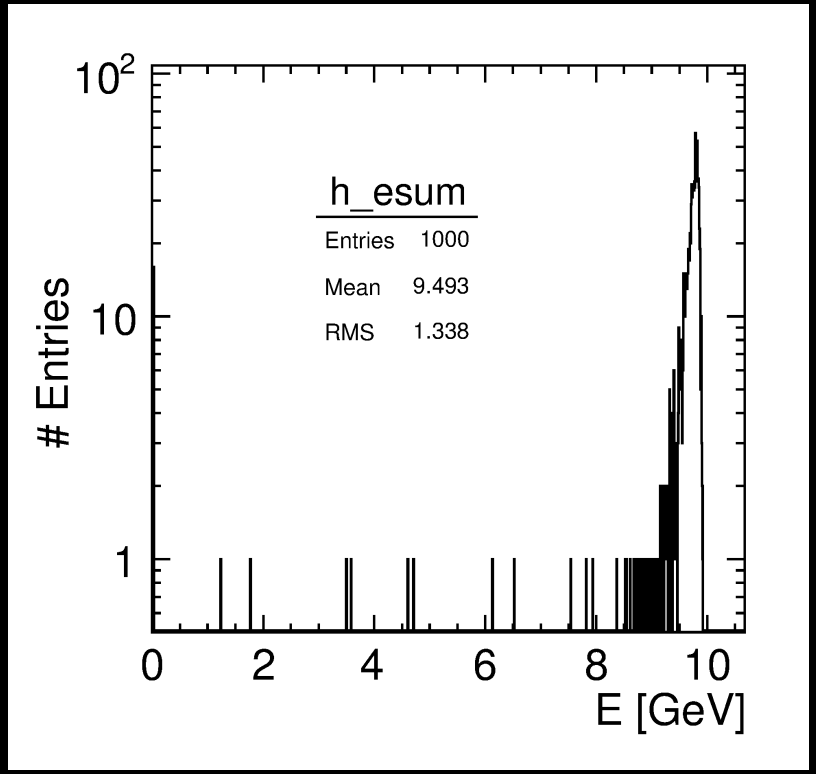
- Comparison between New Geometry and Solid Cone of PbWO4 ranging from $-1.2 \leq \eta \leq -4.5$
- 1000 events
- 10 GeV
- Constant η, ϕ varying between 0 and 2π

```
[jlab@rcas2071 g4macros]$ root -l Fun4All_G4_eEMCAL_ZeroField.C
OBJ: TStyle     eicStyle        AHCAL Style : 0 at: 0x2464e10
root [0]
Processing Fun4All_G4_eEMCAL_ZeroField.C...
Run Fun4All_G4_eEMCAL_ZeroField with...
... nEvents = 1000
... particle type = e-
... momentum (min) = 10
... momentum (max) = 10
... eta (min) = -2
... eta (max) = -2
======================== PHG4Reco::Init() ==============================

*************************************************************
 Geant4 version Name: geant4-10-01-patch-01    (27-March-2015)
                      Copyright : Geant4 Collaboration
                      Reference : NIM A 506 (2003), 250-303
                            WWW : http://cern.ch/geant4
*************************************************************

 ---------- G4TBMagneticFieldSetup::SetStepper() -----------
  Stepper in use: G4ClassicalRK4 (default)
  Minimum step size: 0.005 mm
 -----------------------------------------------------------
<<< Geant4 Physics List simulation engine: QGSP_BERT 4.0

================================================================================
Fun4AllServer: Runnumber forced to 0 by RUNNUMBER IntFlag
Fun4AllServer::setRun(): could not get timestamp for run  0, using tics(0) timestamp: Wed Dec 31 19:00
:00 1969
------------------------------------

List of Nodes in Fun4AllServer:
Node Tree under TopNode TOP
TOP (PHCompositeNode)/
   DCM (PHCompositeNode)/
   DST (PHCompositeNode)/
      G4HIT_eEMCAL (PHIODataNode)
      G4TruthInfo (PHIODataNode)
      PHG4INEVENT (PHDataNode)
   RUN (PHCompositeNode)/
   PAR (PHCompositeNode)/
```

Energy Deposition in 10 GeV Event

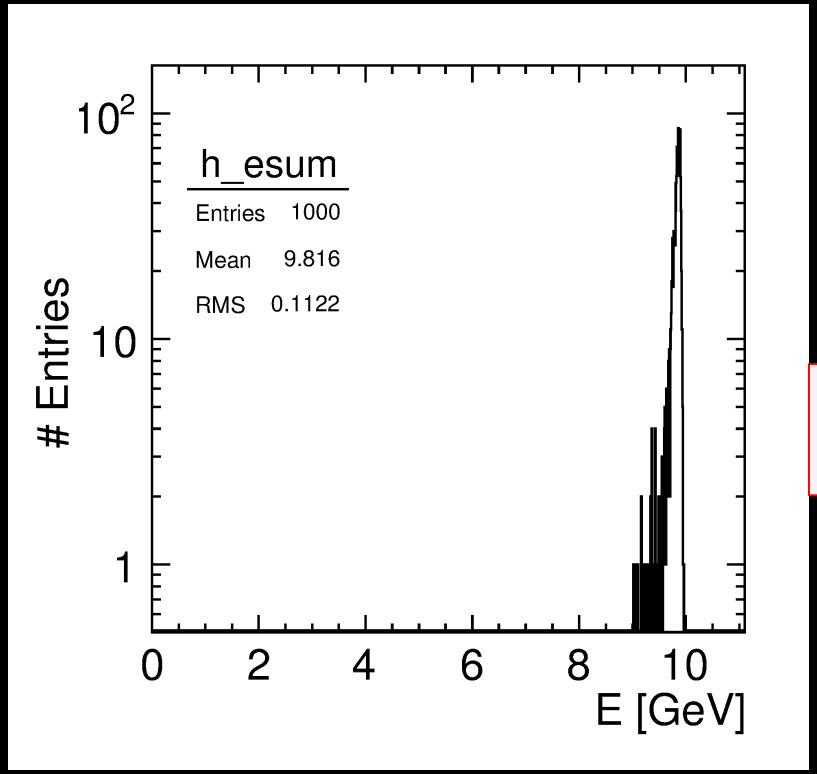


Solid Cone of $PbWO_4$

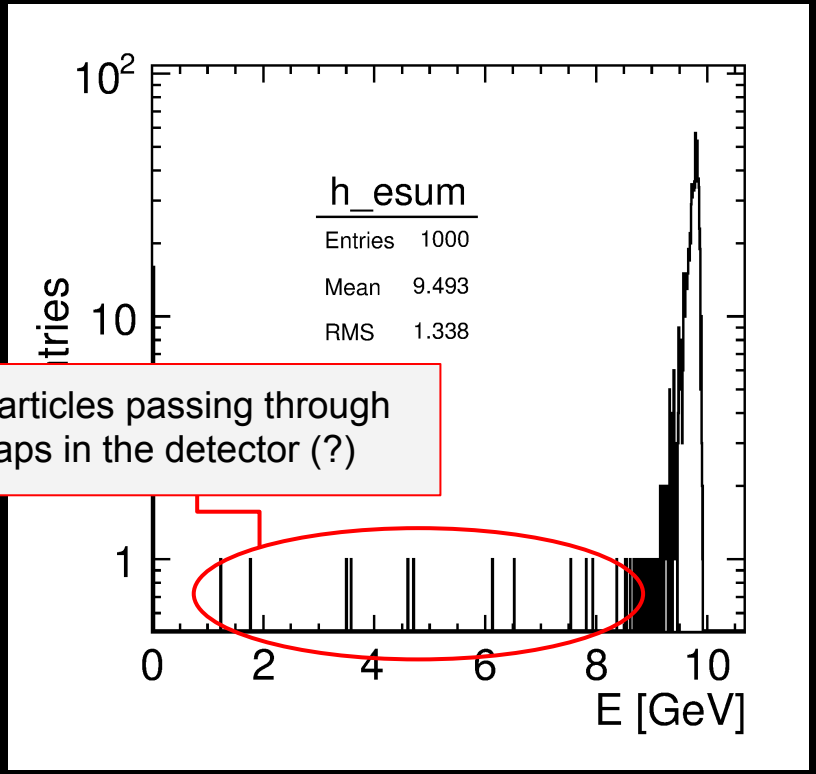


Current Implementation

Energy Deposition in 10 GeV Event

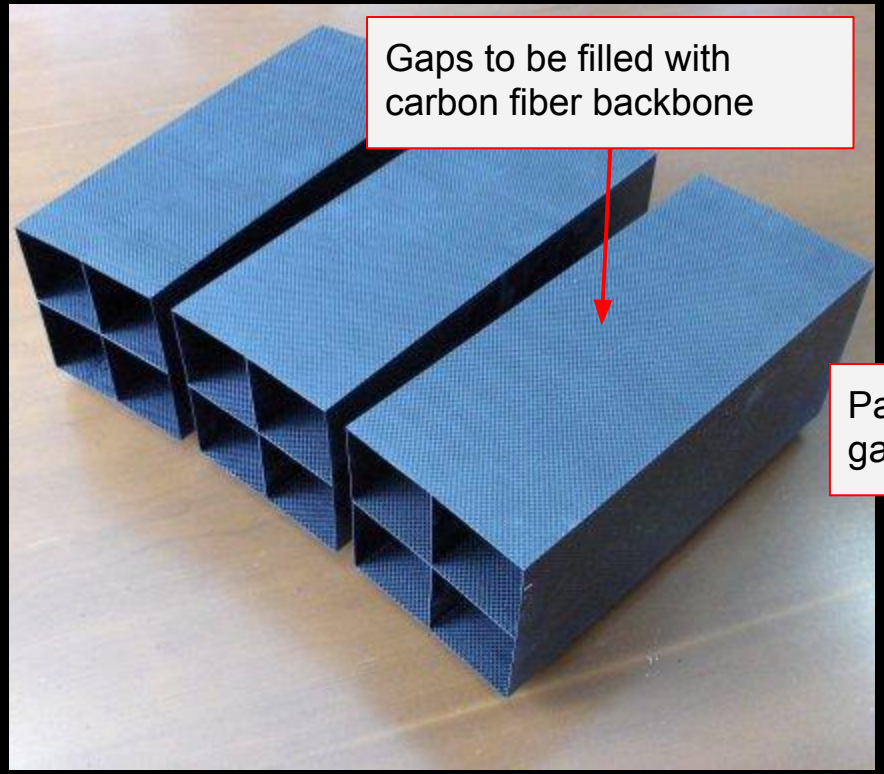


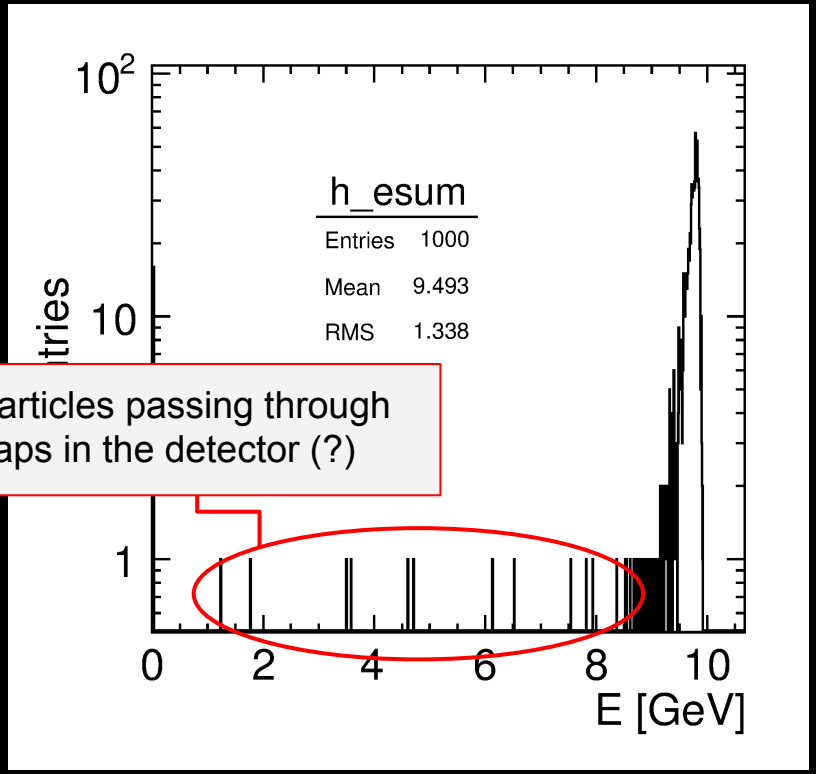
Solid Cone of $PbWO_4$



Current Implementation

Energy Deposition in 10 GeV Event



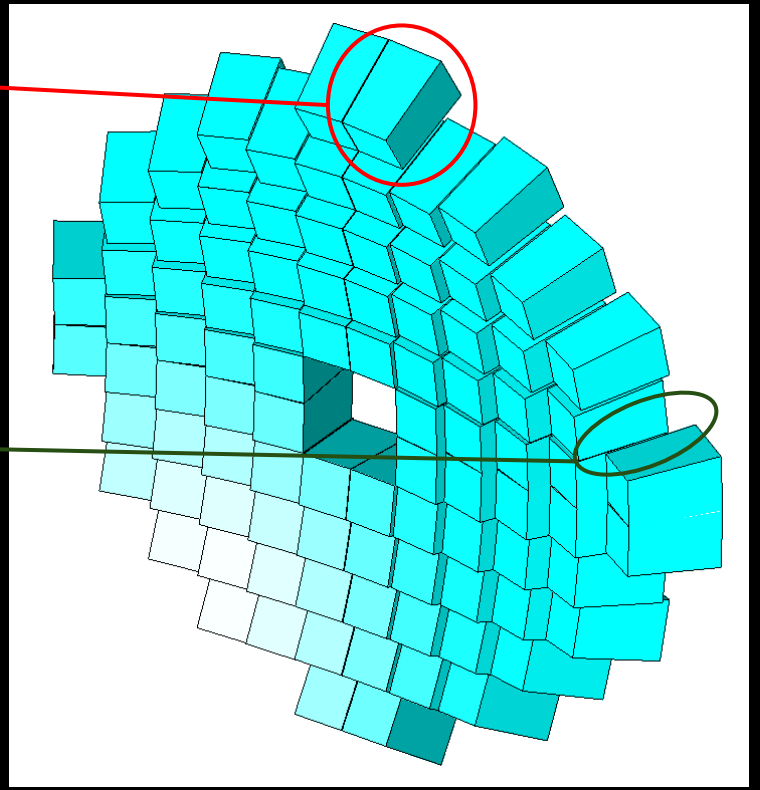


arXiv:0810.1216v1 -- Figure 7.26

Current Implementation

Future Plans

- Each trapezoidal crystal will be split into 16 individual crystals
  - Total of 1472 crystals
- Place in 4-crystal units where 16-crystal units would not fit within mother volume
- Optimise off point geometry to minimize leakage through gaps



Additional Slides

Current Implementation: Software